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Research Paper

Data analysis of current and emerging skills development and training schemes in the air transport sector

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Abstract. The aim of this study was to identify the key gaps and deficiencies in the training schemes and programmes for air transport available in a number of selected sample countries. It was noted that the apprenticeship scheme was the least provided scheme overall. It was also discovered that workers in the air transport sector at higher management levels usually have more collegiate level courses available to train them. There is a potential for further research in this subject, especially an evaluation of the quality of content of the courses and programmes provided is suggested.

Keywords: Air transport, skills development, strategic, tactical, operational, management, apprenticeship, collegiate, non-collegiate, university, training schemes, programmes.

INTRODUCTION

Scope

Transport is crucial for providing the necessary service and infrastructure for linking people to businesses, helping people to get to work, education, events, leisure activities and shopping. Transport connects suppliers with customers and provides easy access for business travellers, tourists and visitors to get to their destinations. With the rapidly growing trend of new technologies and innovation, new skills and competences in transport are needed more than ever before. This subject has now been given priority. More specifically there is a call for research developments to assist in identifying the critical game changers and map the major deficiencies in the skills development practices and training schemes available for future workers in the entire transport industry. For skills developments and training prorgammes in rail and road transport, the interested reader is referred to Cannon *et al*. (2019) and Ulianov *et al*. (2019). As for recent research on skills development training schemes and programmes on marine transport, the interested reader is referred Hu *et al*. (2019).

A material compiled recently by a taskforce with representatives from 4 international airship cargo agencies found that there is a noteworthy deficiency in training schemes available for training the skilled workers needed in their sector (Pierce, 2014).

The aim of this paper is to identify which areas and job categories possess a deficiency in skills development and training schemes in the air transport sector, using data derived from a collective study. It involves a critical review and analysis as well as provides a visual presentation of the data collected from, evaluates and compares the relative availability of education related and training programmes for each area as determined.

METHODOLOGY

The methodology employed for the purposes of this study is presented in Cannon *et al*. (2019), Ulianov *et al*. (2019)

Level/Group	Strategic	Tactical	Operational
Air Traffic Management	Staff Supervisor	Air traffic controllers/Radar Controllers	Flight Info. Service Operators
Airlines	Airline Management	Aeronautical Engineer	Pilots
Airport Operations	Airport Managers	Ground handlers	Baggage handling operatory
Manufacturing	Electronic and avionics manufacturing	Mechanical manufacturing	Composite assembly
Maintenance of aircraft	Ramp/Line Maintenance (A)	Base Maintenance - Avionics & electrical systems maintenance (B1)	Avionics Maintenance (Line and base maintenance) - (B2)
Security	Security Manager	Airport Security Operators	Screening, security controls
Academia	N/A	N/A	N/A

Figure 1. Air transport careers matrix.

and Hu *et al*. (2019). The data which enabled comparisons between a sample of 11 countries: Australia, Belgium, China, Germany, Greece, Ireland, Italy, Portugal, Slovakia, Spain, the United Kingdom, was collected using extensive template implemented in Microsoft Excel.

The data is categorized according to a template of the career matrix shown in Figure 1. Similar approach is presented in Fraszczyk *et al*. (2017). The career matrix is formed from a template laid out collectively, to list job categories and positions in the air transport sector against the three management levels for transport planning, namely:

- Strategic management involves long term planning of company goals and development. It is the highest level of management and the most capital intensive.
- Tactical management involves medium term planning. It includes schedule development, performance assessments and research analysis of congestion levels.
- Operational management involves day to day planning and service delivery (Ahern, 2018).

Job categories include:

- Air traffic management;
- Airlines;
- Airport operations;
- Manufacturing;
- Maintenance of aircrafts;
- Security;
- Academia.

To complete the template, each job category was further subdivided according to the following training schemes and programmes:

- College;
- University;
- Professional Training;
- Apprenticeships;
- Vocational Education and Training (VET & CVET);
- Others.

The data collected has been used to produce graphs that show and allow comparison of data for the particular jobs and their categories. Each management level includes a bar chart that compares training schemes for each job group. The percentages expressed in these bar charts reflect the number of sample countries that provide these types of training schemes at the specified management level. There are also pie charts that express the proportion of training schemes and programmes presented at each management level, as a composite for all the sample countries. The overall analysis for all the sample countries includes average as a measure of central tendency. The data is not considered over a set amount of time, but as it does not express specific numerical values, it can be considered reliable.

ANALYSIS OF DATA

The majority of the data presented in this section is processed with each graph made using Microsoft Excel. The graph in Figure 2 displays the total number of training schemes spread across all the management levels and job categories. There is a large amount of

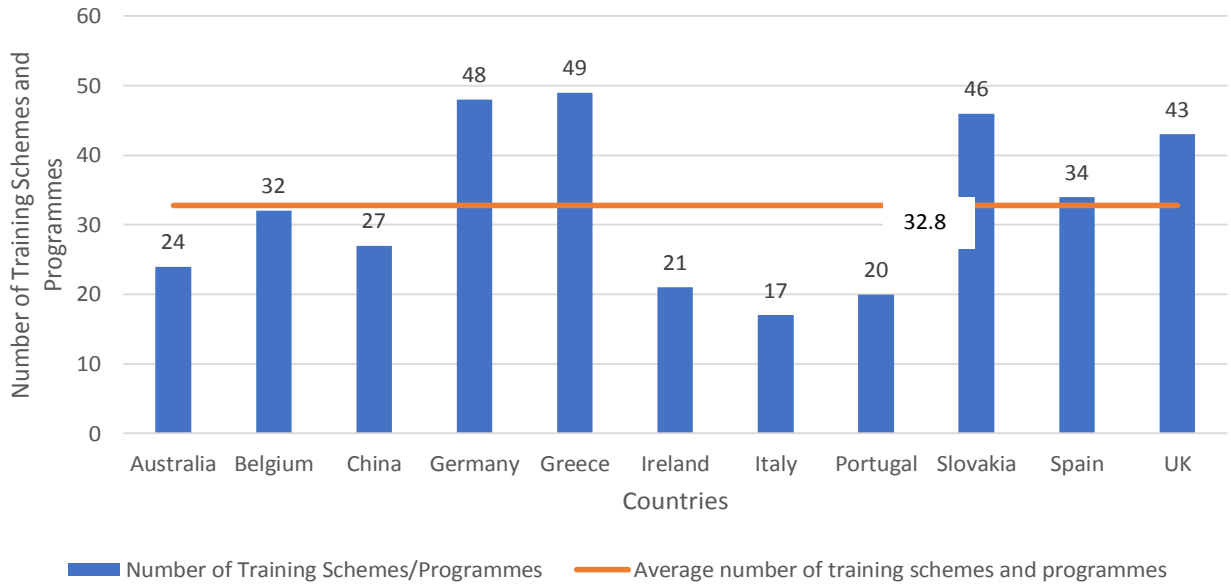


Figure 2. Presence of training schemes and programmes available in all sample countries.

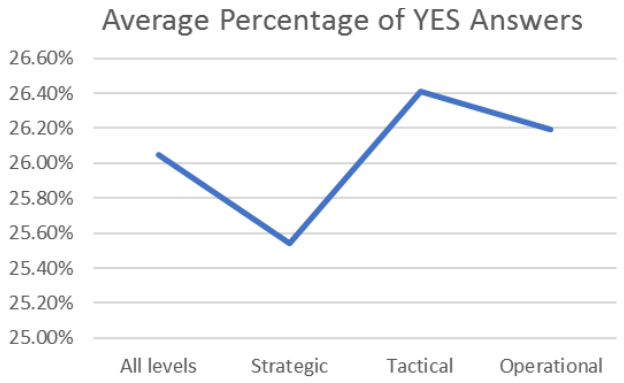


Figure 3. Percentage of training schemes and programmes available as a proportion of all possible programmes in a management level, composite.

deviation around the average of 32.8, which suggests that there is a large variation in training availability among the sample countries. It is observed that Greece has the highest number of training schemes, 49 programmes available in all areas and management levels while Italy has the lowest number of schemes, 17 schemes. However, these numbers do not necessarily mean that there are skill development practices and/or training schemes available for every job category in every management level.

Distribution of training schemes and programmes in air transport in categories and management levels

For further levels of comparison, details about the sample countries with outlier and median values in Figure 2 are used. Thus, further details about Germany, Greece, Spain, Portugal and Italy are used to compare the level of civilian air travel in the country and the economic value that each country's air transport sector adds.

Figure 3 shows the actual proportion of skills development and training schemes that are available, out of all the potential courses that could be provided at all management levels in all the sample countries. It can be seen in Figure 3 that there is an average of 26% at all management levels when seen as a composite for all the sample countries. There is little variation in this average even when the management levels are split according to their component parts.

Figure 4 displays the proportion of training schemes and programmes available at the tactical management level. It can be seen that there is large variation about the average value at 26.4%. The country with the highest

Figure 4. Percentage of training schemes and programmes available as a proportion of all possible programmes at the tactical management level for sample countries.

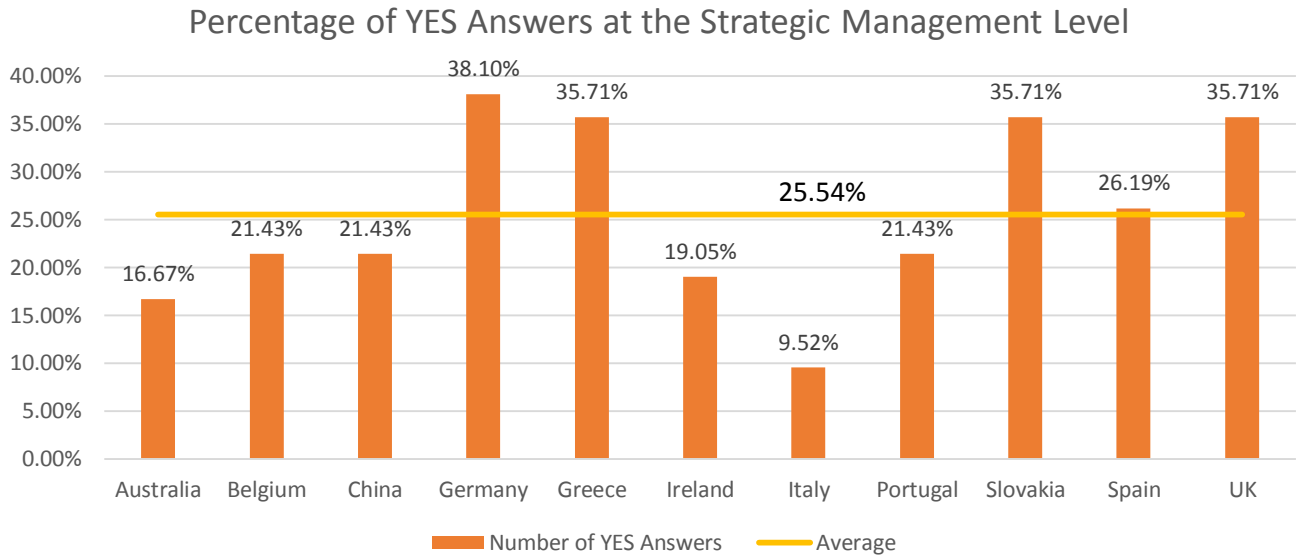


Figure 5. Percentage of training schemes and programmes available as a proportion of all possible programmes at the strategic management level for sample countries.

proportion is Greece at 45.2% and the country with the lowest proportion is Portugal at 9.5%.

Figure 5 displays the proportion of training schemes and programmes available at the strategic management level. It can be seen that there is large variation about the average value at 25.5%. The country with the highest proportion is Germany at 38.1% and the country with the lowest proportion is Italy at 9.5%. It does not follow the overall composite graph values.

Figure 6 displays the proportion of training schemes and programmes available at the strategic management level. It can be seen that there is large variation about the average value at 26.2%. The country with the highest proportion is Germany at 38.1% and the country with the lowest proportions are Italy and Ireland at 11.9 %. It does not follow the overall composite graph values.

It is observed in Figure 6A that Germany has the highest number of civil aircrafts available, 633 aircrafts. This is closely followed by Spain and Italy. In Figures 6B and 6C, it is observed that Germany has the highest values for both the production value and value added at cost factor. This suggests that out of all the outlier countries

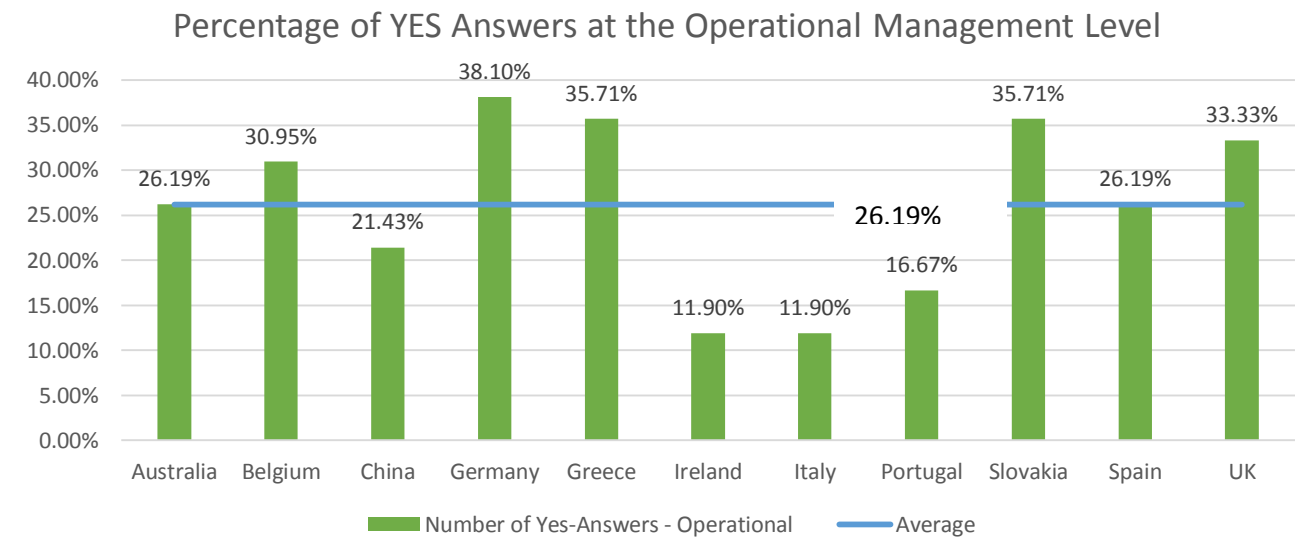


Figure 6. Percentage of training schemes and programmes available as a proportion of all possible programmes at the operational management level for sample countries.

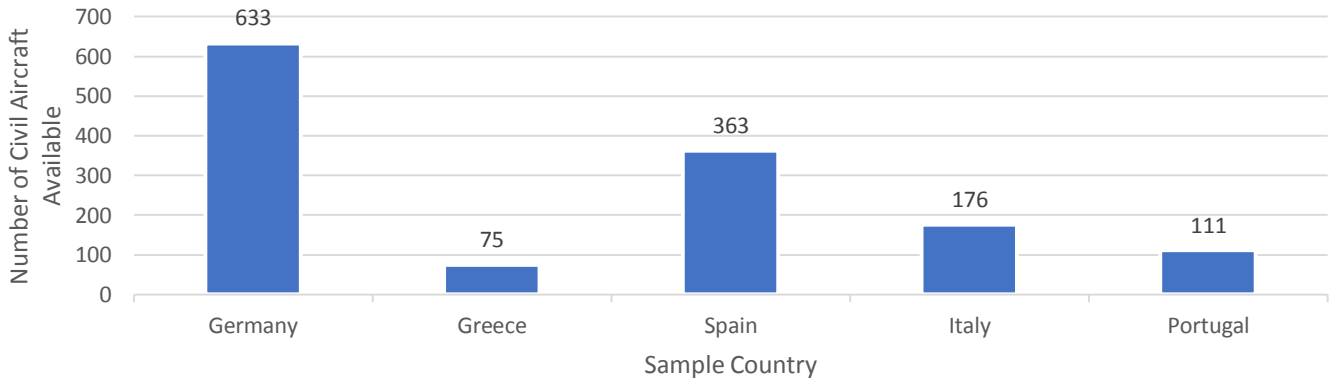


Figure 6A. Number of civil aircraft present in outlier sample countries (Eurostats, 2016).

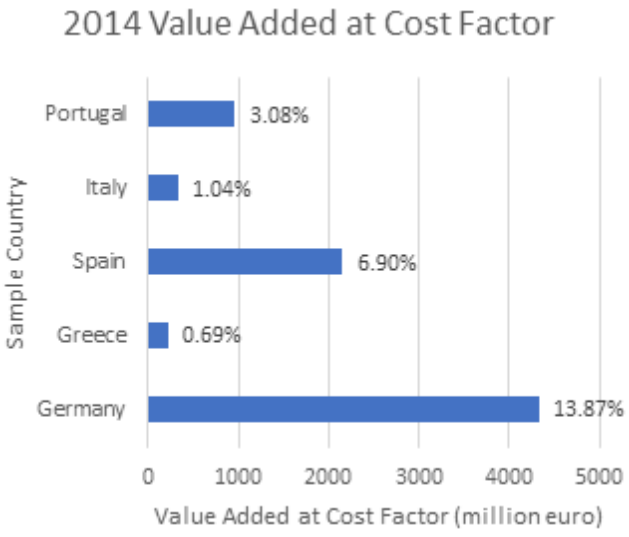


Figure 6B. Value added for cost factor in 2014 (Eurostat).

sampled, air transport had the highest economic value in Germany.

In 2104, 6.9% of the value added to the European Union by the air transport industry was provided by Spain while Greece provided less than 1% of this same value. Also, Italy had the second highest production value of the outlier sample countries. It contributed less than 10% of the air transport production value amongst EU member countries, while Greece contributed only 0.6%.

Distribution of training schemes and programmes amongst fields of education

The chart in Figure 7 shows that most training schemes are provided at the University level at 25%, followed by those at the VET & CVET level at 20%. Apprenticeships are the least utilised training scheme at 6%, followed by Technical Colleges at 11%. Professional training and

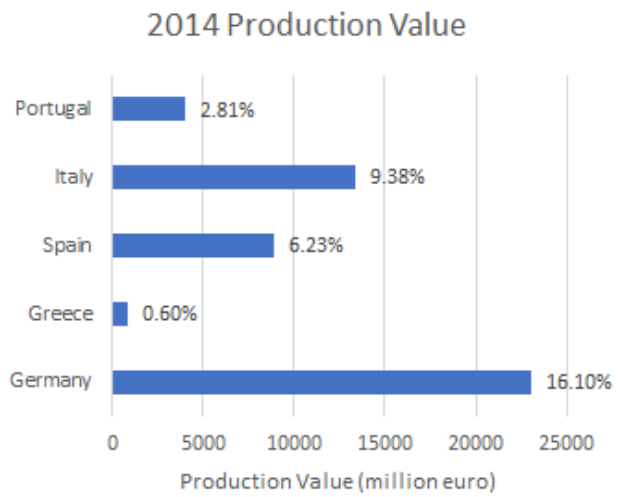


Figure 6C. Production value in 2014 (Eurostat).

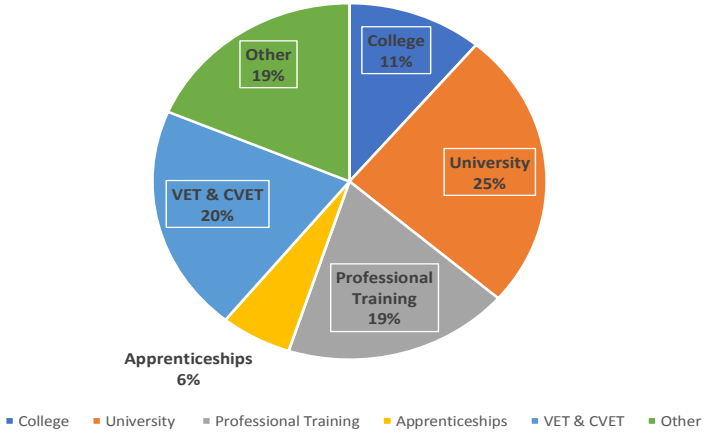


Figure 7. Proportion of training schemes provided by each field of education.

Other types of training schemes at the midpoint, with both types contributing 19% of the types of education available.

Recalling Figure 8 that shows the distribution of training schemes and programmes within each management level, it can be noted that at the Strategic level, most courses are provided at the University level, followed by the College level. At the tactical management level, most of the training courses are also provided at the University level, followed by the VET & CVET. Unlike the other management levels, most of the operational management courses are taught at the VET & CVET level, followed by those taught at the professional training level. However, at all management levels, apprenticeship schemes provide the least number of courses.

Several points can be drawn by comparing the overall proportions seen in Figure 7 with the proportions seen at each management level in Figure 8. Firstly, none of the fields of education at any of the management levels have a similar distribution to those seen for the composite sample data for all education formats in Figure 7. At the University level, for example, there is a slight deviation in values between the composite data for education levels and composite data for those taught at only the tactical management level. However, there is a large deviation in the values between the composite data for the education formats and the composite data for those taught at the strategic and tactical management levels. Secondly, the percentage contribution for each education format differs greatly at each management level and between those seen in Figure 7.

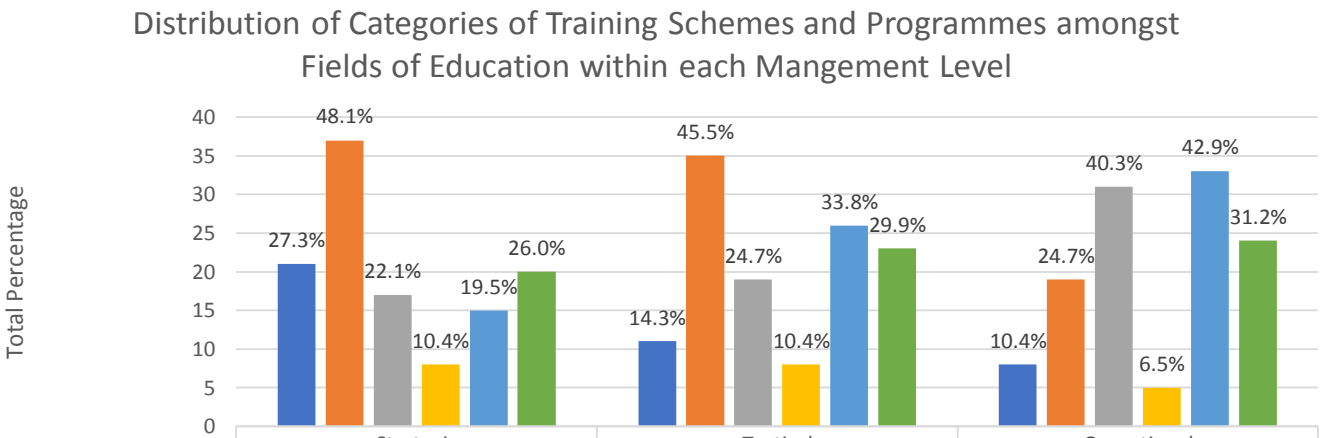
Distribution of training schemes and programmes within management levels

Figure 8 shows proportion of the schemes provided for every education field and management level. Figures 9, 10 and 11 show the distribution of training schemes and programmes within each of the management levels. These figures further expand on the data displayed in Figure 8.

Figure 9 shows that at the Strategic Management level that most of the courses are provided at the University level, with it occupying 31% or nearly one-third of all Strategic level courses. When combined with the College courses, nearly half of all Strategic level training is provided at an education of higher institution. In contrast, the less formalised apprenticeships account for only 7% of training schemes provided at the strategic management level.

Figure 10 shows that there are far fewer higher education courses provided at the tactical management level. Like the strategic level, most courses are provided at the University level, with this type of education providing nearly 30% of all training schemes available at the tactical level. However, the next most common training scheme is provided by the VET & CVET programmes at 21%. In comparison to the strategic level, only 9% of training schemes are provided by Colleges at the tactical level, which is half those provided at the strategic level. Much like the strategic level, apprenticeships still contribute the least proportion of courses to training schemes for the tactical level at only 6%.

It can be seen in Figure 11 that most courses are provided by professional training. This is in stark contrast to the distributions seen at both the strategic and tactical management levels, where University education contributed around one third of the education related and training schemes at these levels. Most of the training schemes provided at the operational management level are taught in outside classroom settings, with over 50% of these training schemes likely to be taught to those already working. This is likely due to the fact that the jobs at the operational level do not require critical thinking skills or theoretical knowledge taught in higher institutions (Morrish, 2015), but rather the hands-on knowledge of the systems and machinery used in a day to day work.



	Strategic	Tactical	Operational
College	21	11	8
University	37	35	19
Professional Training	17	19	31
Apprenticeships	8	8	5
VET & CVET	15	26	33
Other	20	23	24

Figure 8. Proportion of training schemes provided by each field of education at each management level.

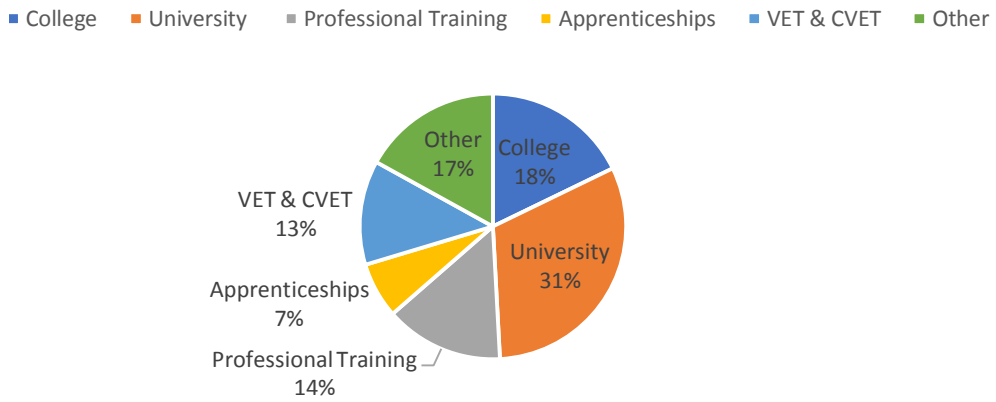


Figure 9. Distribution of training schemes and programmes within the strategic management level.

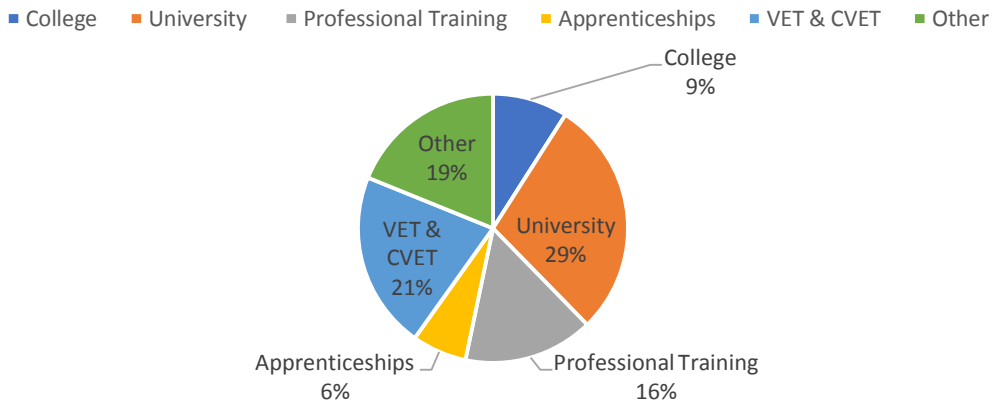


Figure 10. Distribution of training schemes and programmes within the tactical management level.

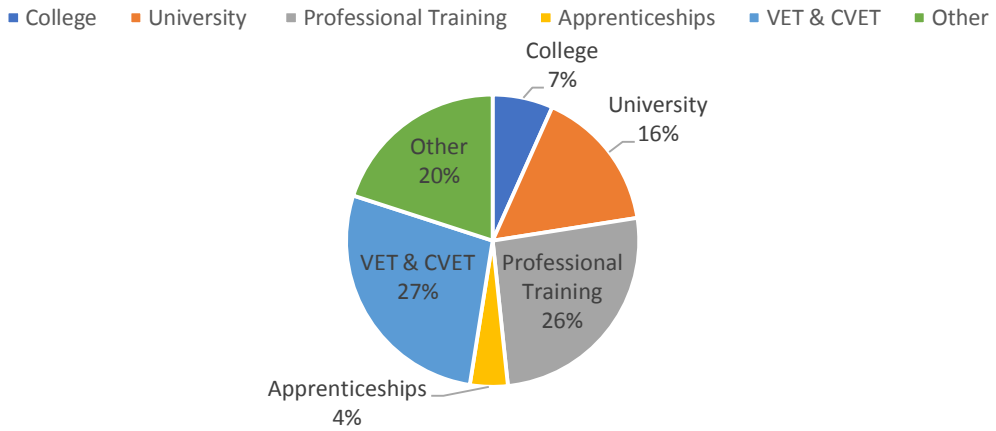


Figure 11. Distribution of training schemes and programmes within the operational management level.

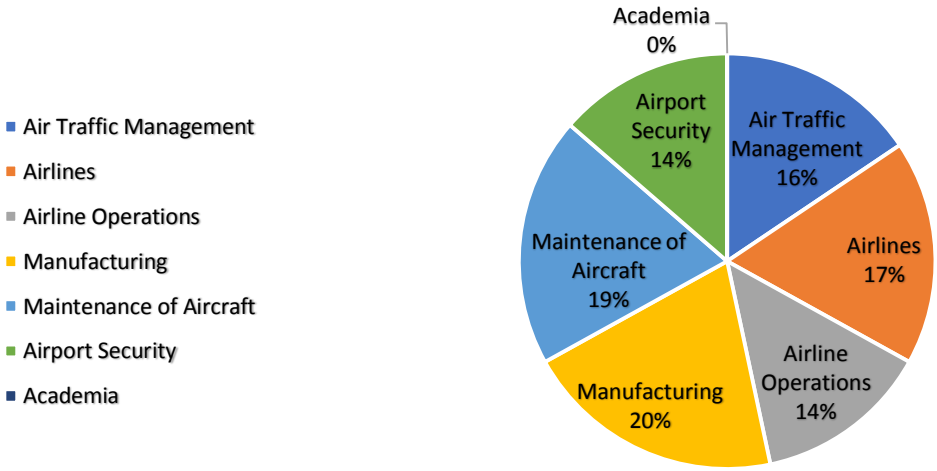


Figure 12. Distribution of training schemes and programmes amongst job groups.

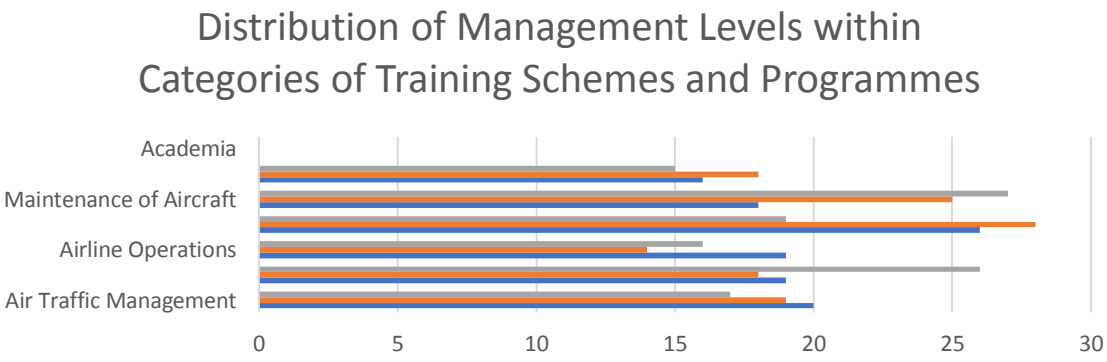
Distribution of training schemes and programmes amongst job groups

Figure 12 shows the distribution of training schemes amongst all the job groups categorised in the careers matrix in Figure 1. Most skills development practices and training schemes are offered in the Manufacturing job group, at 20%. This is closely followed by those offered for the maintenance of aircraft at 19% and the Airlines job group at 17%. There is little or no data available on the training schemes for those in the Academia sector, which suggests that there are no specialised, country specific research programmes in this sector. There is some research available in this sector, but it mainly involves international research into the economic impact of changes in air policy and planning (Schlumberger and Giovannitti, 2017).

Figure 13 provides a more in-depth look at the distribution of training schemes within each job group and its presence within each management level. It can be seen that most Manufacturing at the tactical management level has the highest number of training schemes at 28, closely followed by Aircraft Maintenance at the operational level and both Airlines at the operational level and Manufacturing at the strategic level. Academia has the least number of training schemes at 0, with Airline Operations at the tactical level having the second fewest number of training schemes. It can generally be observed that there is no even for the distribution of training schemes at within each job group or even within each management level of those job groups.

Distribution of training schemes and programmes within air traffic management

This section examines the Air Traffic Management job group in further detail, with special focus being placed on the areas where there is a clear deficiency in provided training schemes and programmes.



	Air Traffic Management	Airlines	Airline Operations	Manufacturing	Maintenance of Aircraft	Airport Security	Academia
Operational	17	26	16	19	27	15	0
Tactical	19	18	14	28	25	18	0
Strategic	20	19	19	26	18	16	0

Figure 13. Distribution of training schemes and programmes amongst job groups and within management levels.

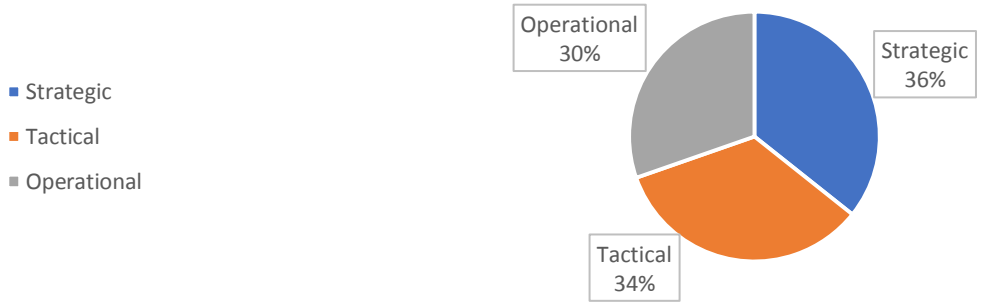


Figure 14. Average distribution of jobs amongst management levels in air traffic management.

Figure 14 shows the distribution of training schemes and programmes in the air traffic management. Nearly 40% of the 56 courses provided in air traffic management are provided at the strategic management level, closely followed by the proportion of courses provided at the tactical level. Operational provides the least proportion of courses to the air traffic management group.

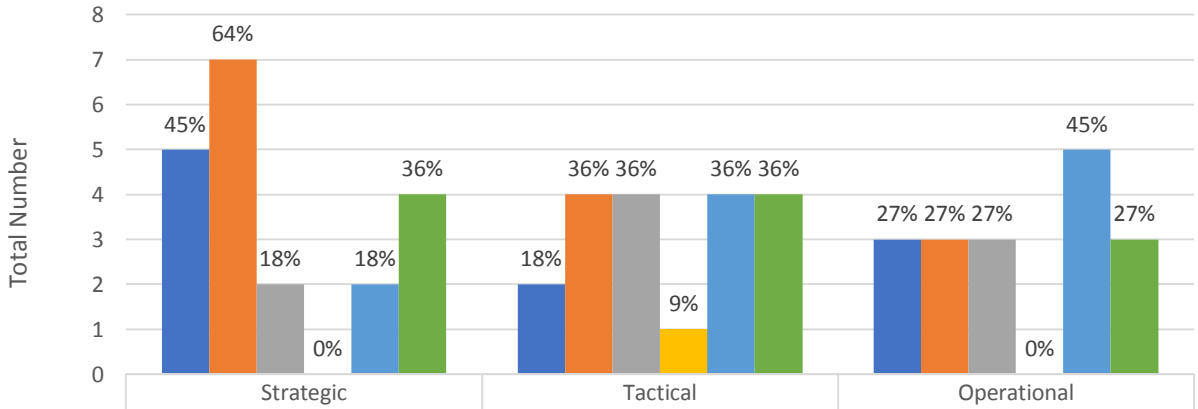
Figure 15 shows the distribution of training schemes of Training Schemes amongst all Fields of Education and Levels of Management, for Air Traffic Management. The graph shows that in the Air Traffic Management job group, it follows the general trend that Apprenticeships provide the least courses for all the management levels. The United Kingdom provides the only apprenticeship scheme for air traffic and radar controllers, while most other countries prefer to train these workers in vocational courses or higher educational institutions.

Although there is an uneven distribution of courses amongst the management levels, it can be derived that most of the courses are provided at the University level. In contrast to the strategic and tactical management levels, most courses are provided at the operational level, are CVET & VET courses, which follows the trend laid out later on.

Distribution of training schemes and programmes within airlines

This section examines the Airlines job group in further detail, with special focus being placed on the areas where there is a clear deficiency in provided training schemes and programmes.

In Figure 16, it is observed that most of the courses for Airlines are provided at the operational management level. Specifically, 41% of the available 63 courses are provided at the operational management level, which follows the trend seen in the Air Traffic Management section. Figure 17 shows the distribution of schemes amongst the fields of education.



	Strategic	Tactical	Operational
College	5	2	3
University	7	4	3
Professional Training	2	4	3
Apprenticeships	0	1	0
VET & CVET	2	4	5
Other	4	4	3

Figure 15. Distribution of training schemes amongst all fields of education and levels of management, for air traffic management in sample countries.

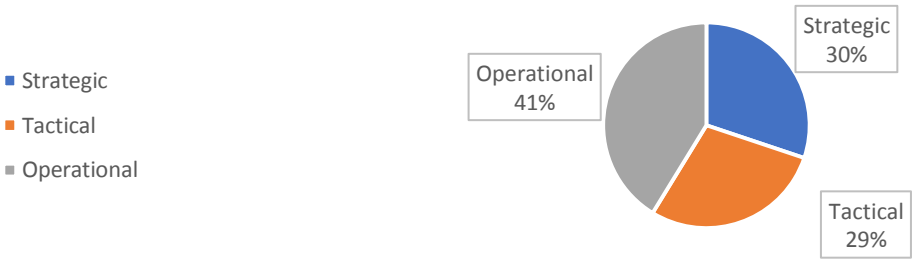


Figure 16. Average distribution of training schemes and programmes spread across the management levels in airlines.

Figure 17 follows the general trend seen later, with most of the training schemes in the strategic and tactical management levels provided by higher education courses. However, at the operational level, most of the training schemes are provided at the Professional Training level, not by VET & CVET courses, though combined with Apprenticeships, it provides the second most training schemes at this level. It can be noted that at the tactical management level, nearly all the sample countries have a university level course available.

Unlike the previous graphs there is some variation over which training scheme provides the least number of courses. Although there is some evidence of the general trend that shows that the apprenticeship scheme provides a low number of courses, there are courses that provide even less. In Figure 17, at both the strategic and tactical level there are no courses provided by VET & CVET, while at the operational level a large number of courses are provided by this type of training scheme. In contrast, the lowest number of courses provided at the operational level are the college and apprenticeship courses which are each provide by only 1 country out of a potential 11. Specifically, Australia provides the only college course and China provides the only apprenticeship scheme for training pilots. Most other countries train these workers at the University level or the VET & CVET course.

Distribution of training schemes and programmes within Airline operations

This section will examine the Airline Operations job group in further detail, with special focus being placed on the areas where there is a clear deficiency in provided training schemes and programmes.

Figure 18 shows that out of 63 available courses, nearly 40% are provided at the strategic management

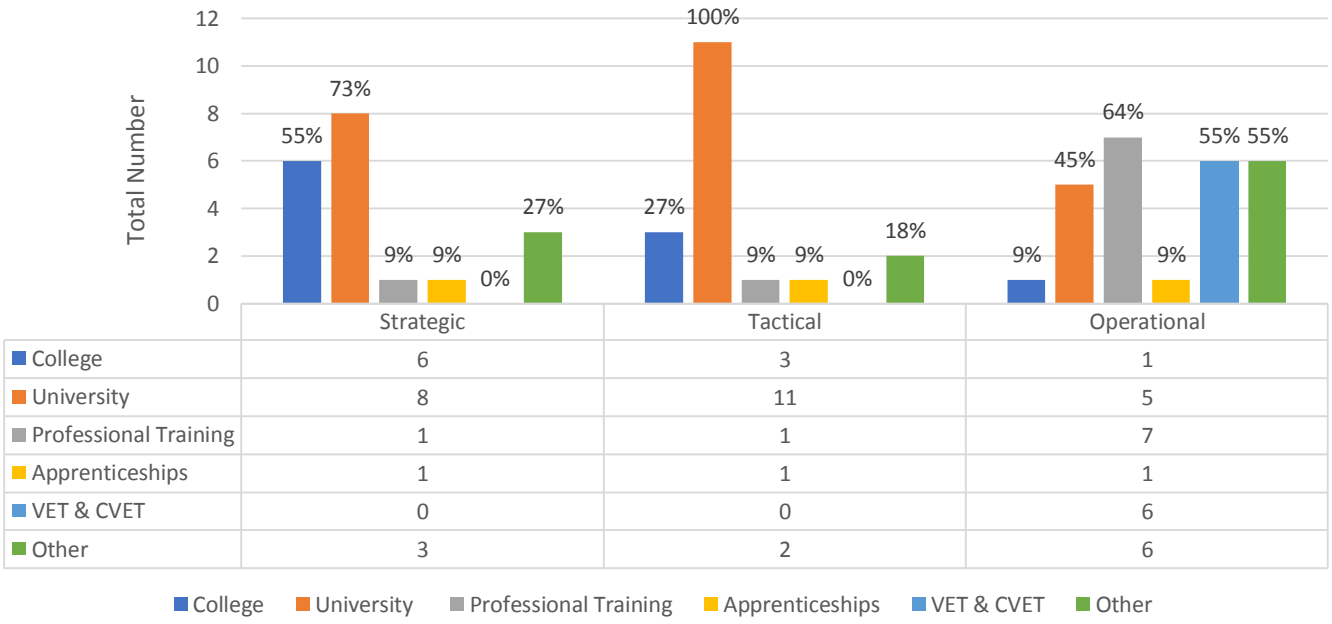


Figure 17. Distribution of training schemes amongst all fields of education and levels of management, for airlines in sample countries.

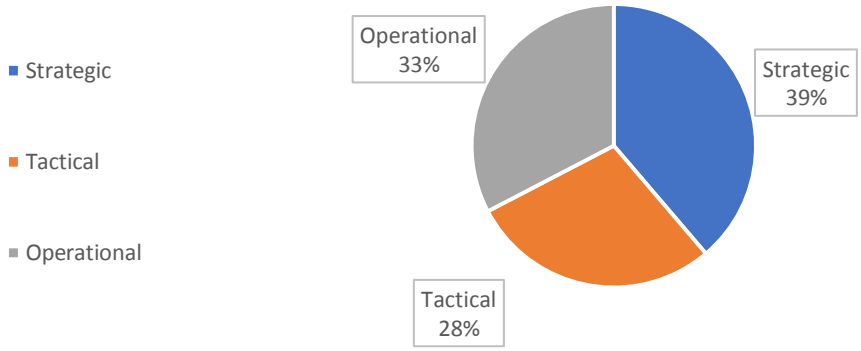


Figure 18. Average distribution of training schemes and programmes spread across the management levels in airline operations.

level, while one third are provided at the operational level. Tactical management level provides the smallest proportion of courses at 28%.

The data in Figure 19 follows the general trend seen in previous sections. Most of the training schemes at the strategic level provided by institutions of higher education. There are also no countries that provide apprenticeship schemes as a form of education at any of the management levels.

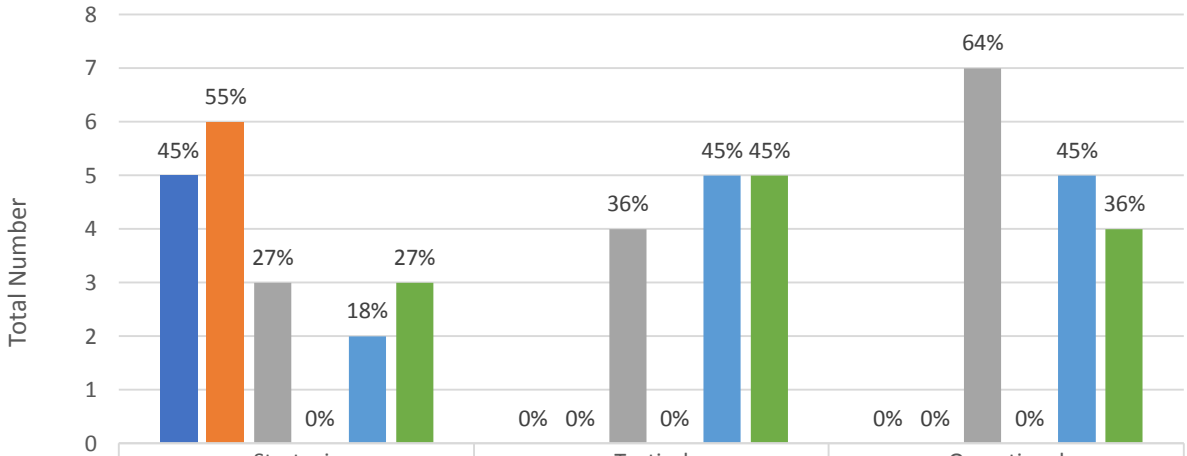
There is some variation from the general trend seen in Figure 17, most schemes at the tactical level are provided in the form of professional training or other education programmes. At the operational level, most of the courses are also provided via professional training, while nearly 50% of the sample countries also provide VET & CVET and other forms of education as training schemes. In fact, only two countries, Belgium and Italy provide VET & CVET courses to workers at the strategic level i.e. airport managers.

It should be noted that the tactical and operational level have no college or university training schemes, unlike other job groups.

Distribution of training schemes and programmes within Manufacturing

This section examines the Manufacturing job group in further detail, with special focus being placed on the areas where there is a clear deficiency in provided training schemes and programmes.

Figure 20 shows the distribution of training schemes and programmes in the manufacturing job group. Nearly 40% of the 73 courses provided in manufacturing are



	Strategic	Tactical	Operational
College	5	0	0
University	6	0	0
Professional Training	3	4	7
Apprenticeships	0	0	0
VET & CVET	2	5	5
Other	3	5	4

Figure 19. Distribution of training schemes amongst all fields of education and levels of management, for airline operations in sample countries.

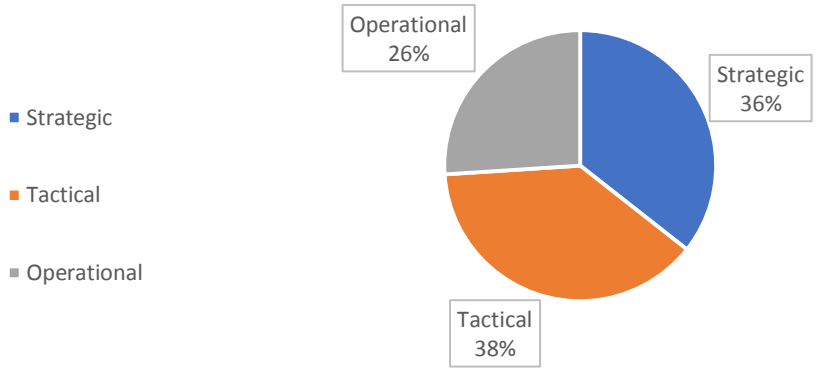
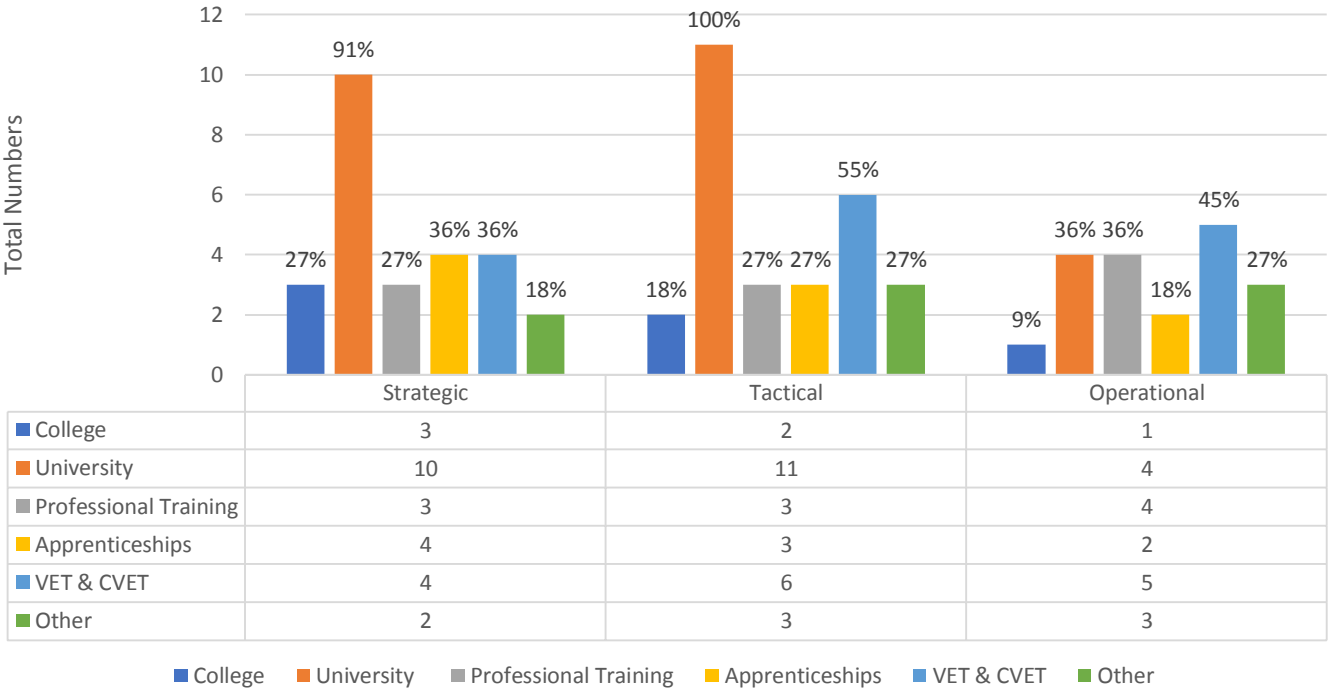


Figure 20. Average distribution of training schemes and programmes spread across the management levels in manufacturing.

provided at the tactical management level, closely followed by the proportion of courses provided at the strategic level. The operational management level provides the least proportion of courses at 26% of all courses for this job group.

The data in Figure 21 follows the general trend seen in previous sections, as nearly all the sample countries provide the University course as a form of training at the strategic and tactical management level. However, the next most numerous course provided at these levels are VET & CVET courses, not the college courses that are expected. Also, it can be noted that the least present course at all the management levels is not the apprenticeship scheme. Instead, at the strategic level, the least provided for schemes are the other avenues of education, closely followed by the professional training and college courses.

At the operational level, only 45% of sample countries provide VET & CVET training courses, but this is the most widely available type of training scheme for composite assembly workers. Greece is the only country that provides college-level courses to train workers for



	Strategic	Tactical	Operational
College	3	2	1
University	10	11	4
Professional Training	3	3	4
Apprenticeships	4	3	2
VET & CVET	4	6	5
Other	2	3	3

Figure 21. Distribution of training schemes amongst all fields of education and levels of management, for manufacturing in sample countries.

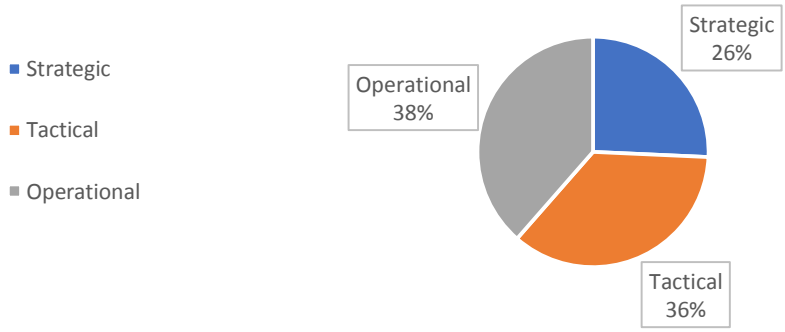


Figure 22. Average distribution of training schemes and programmes spread across the management levels in maintenance of aircraft in sample countries.

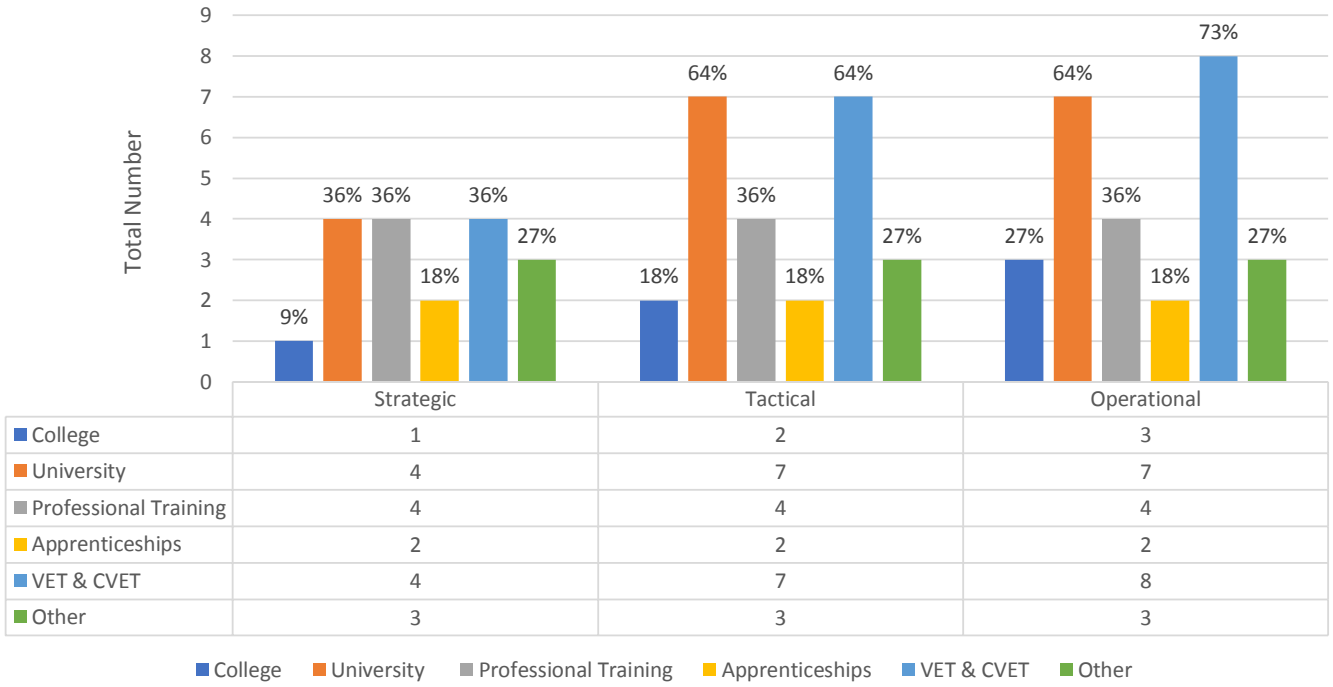
operational manufacturing.

Distribution of training schemes and programmes within Maintenance of aircraft

This section examine the maintenance of aircraft job group in further detail, with special focus being placed on the areas where there is a clear deficiency in provided training schemes and programmes.

Figure 22 shows the distribution of training schemes and programmes in the maintenance job group. Nearly 40% of the 70 courses provided in maintenance of aircraft are provided at the operational management level, closely followed by the proportion of courses provided at the tactical level. Over one quarter of the courses are provided at the strategic management level but provides the least number of courses in maintenance of aircraft.

Figure 23 shows the distribution of training schemes available for the maintenance of aircraft job group. It can be noted that there is a marked difference from the general trend seen in previous sections. Around 40% of the sample countries provide University level training at the strategic management level. Greece is the only country provides college level courses at the strategic management level, while two of the sample countries provide apprenticeship schemes for workers at the strategic level. At the operational level more than 70% of the sample countries provide VET & CVET training



	Strategic	Tactical	Operational
College	1	2	3
University	4	7	7
Professional Training	4	4	4
Apprenticeships	2	2	2
VET & CVET	4	7	8
Other	3	3	3

Figure 23. Distribution of training schemes amongst all fields of education and levels of management, for maintenance of aircraft in sample countries.

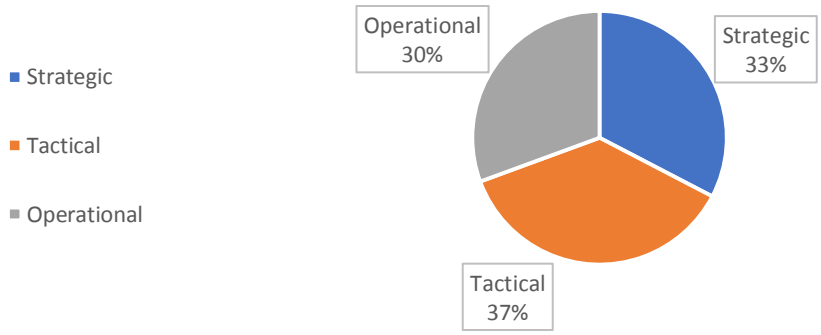


Figure 24. Average distribution of training schemes and programmes spread across the management levels in airport security.

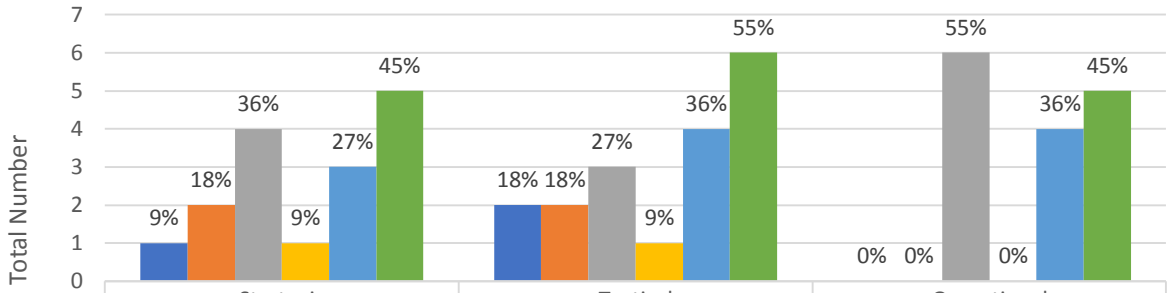
schemes, which follow the expected trend. At both the tactical and operational level, apprenticeship schemes are the least available training schemes. However, at the tactical level, this is tied with college courses available. At the tactical level both university level and VET & CVET courses are provided by most of the sample countries.

Distribution of training schemes and programmes within airport security

This section examines the airport security job group in further detail, with special focus being placed on the areas where there is a clear deficiency in provided training schemes and programmes.

Figure 24 shows the distribution of training schemes and programmes in the airport security job group. Nearly 40% of the 49 courses provided in airport security are provided at the tactical management level, closely followed by the proportion of courses provided at the strategic level. Operational provides the least proportion of courses to the airport security group.

Figure 25 shows the distribution of training schemes amongst the airport security job group. Apprenticeship schemes are the least widely available training schemes out of the training schemes provided by the sample countries. Germany is the only country that provides apprenticeship schemes at the strategic and tactical



	Strategic	Tactical	Operational
College	1	2	0
University	2	2	0
Professional Training	4	3	6
Apprenticeships	1	1	0
VET & CVET	3	4	4
Other	5	6	5

Figure 25. Distribution of training schemes amongst all fields of education and levels of management, for airport security in sample countries.

level. None of the sample countries provide apprenticeship schemes, college or university level courses at the operational level. More than 50% of the sample countries provide professional training at the operational level while 45% of the sample countries train these workers using other forms of education. At both the tactical and strategic level the most popular form of training scheme are other forms of education.

Unlike previous sections college and university level courses are not widely available to train workers for jobs at both strategic and tactical level. Exception is China which provides some of the only college level courses to train workers at the strategic and tactical level. Germany and Slovakia provide the only university level courses train workers are the strategic and tactical level.

EVALUATION

The analysis suggests there is a deficiency in the availability of training schemes and programmes for workers at all management levels and in all job categories. On average only 26% of a potential 1386 training schemes and programmes are available amongst the sample countries chosen. Although there is a great deal of variability when the data is categorised according to job category or education format, some general trends can be observed.

Firstly, there is a clear indication that the more capital intensive corporations prefer their workers to have more initial training before even starting their careers. This is proved by the fact that for most job categories, the most widely available courses for workers in the strategic and tactical management level are college and university level courses. There are some exceptions to this trend, particularly workers at tactical level air traffic management and airline operations, strategic level maintenance workers and both strategic and tactical level airport security workers.

Secondly, there is a clear deficiency in the presence of apprenticeship schemes available amongst all the sample countries. Most job categories had only one or two countries that provided apprenticeship schemes for any workers at any management levels. Germany is the country most likely to have apprenticeship schemes, closely followed by Slovakia and the United Kingdom. Most of these apprenticeship schemes are available to workers at the strategic and operational management levels of the manufacturing and maintenance job groups.

Thirdly, most workers at the operational level of management are trained using vocational education formats. More than 40% of the countries sampled provide VET & CVET courses or professional training as a form of training for operational level workers. This suggests that operational workers are more likely to have on the job training in order to work at this management level.

There is little or no data available for workers in the academia job category. Possibly intensive programmes as presented in Marinov and Ricci (2012) can be considered for this type of job category. There is no clear job title for any workers at any management level in this category and consequently no data collected for this category. Although this implies that there is no research being undertaken in the field of air transport, this is patently untrue. There are several international organisations that collect and disseminate data on passengers and air transport enterprises. However, this data is collected by governments and published by international bodies, not individual researchers.

There is no well-defined correlation between job group,

management level and presence of training schemes. However, it can be extrapolated that there is some relationship between contribution of the sector to the economy and the type of training available for its workers. For example, Germany is most likely to provide apprenticeship schemes and its air transport sector provides a higher contribution to its economy. In contrast, the analysis suggest that Greece has the number of possible training schemes and programmes on skills development for air transport but it contributes less than 0.7% to the EU's overall economy.

CONCLUSIONS AND FUTURE WORK

This paper sought to identify the major deficiencies in the skills development practices and training schemes available for workers in the air transport industry. The data gathered showed that the number of available courses varied widely amongst the sample countries. Apprenticeship schemes were the least widely available courses in nearly all the job categories and sample countries. Also, positions that require workers to handle higher levels of responsibility have more collegiate courses available to train these workers. To resolve this deficiency more skills development training schemes and programmes on air transport related schemes should be made available in all the sample countries.

Since non-collegiate courses are the least widely available, governments should work with business owners to provide more. This is because apprenticeship schemes are most likely to provide social and occupational mobility, as they allow earning and learning (Brooks, 1994).

There are several potential avenues for further work. Firstly, the data could be collected over a set period of time, from more sample countries. The data could be selected over a period of 5 to 10 years, to account for variability due to the amount of time that has passed. The current data is mainly focused on EU member countries, who have a distinct economic advantage. More sample countries, especially those outside the EU should be used, to reduce the bias created by gathering data from developed nations.

Secondly, the level of skills and amount of responsibility required for each job group should be presented at a measurable comparison level. Job categories that higher skill levels could have more collegiate courses provided while less planning-based jobs could have more non-collegiate courses provided. Thus, this research would help determine which job groups would actually benefit from having more diversified training schemes.

Thirdly, further study can be undertaken to research the actual number of courses in all regions of the selected sample countries. This data could be compared with both the number of workers trained in each sample country and how many workers the sample country needs to maintain its current workforce and determine specifically which courses need to be made more widely available.

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